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(54) **Steps for escalator with high speed inclined section**

Rolltreppe mit geneigtem Hochgeschwindigkeitsabschnitt

Escalateur doté d'une section inclinée à haute vitesse

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(73) Proprietor: **MITSUBISHI DENKI KABUSHIKI
KAISHA**
Chiyoda-ku, Tokyo 100-8310 (JP)

(72) Inventors:
• **Ogura, Manabu**
Tokyo 100-8310 (JP)
• **Yumura, Takashi**
Tokyo 100-8310 (JP)
• **Haruta, Yasumasa**
Tokyo 100-8310 (JP)

- **Yoshikawa, Tatsuya**
Tokyo 100-8310 (JP)
- **Nagaya, Shinji**
Tokyo 100-8310 (JP)
- **Nakamura, Joichi**
Hakatu-ku, Fukuoka
812-011 (JP)

(74) Representative: **Sajda, Wolf E. et al**
Meissner, Bolte & Partner GbR
Postfach 86 06 24
81633 München (DE)

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DescriptionBACKGROUND OF THE INVENTION5 1. Field of the Invention

[0001] This invention relates to an escalator with a high speed inclined section in which the steps move faster in the intermediate inclined section than in the upper and lower landing sections.

10 2. Description of the Related Art

[0002] Nowadays, a large number of escalators of great height are installed in subway stations or the like. In an escalator of this type, the passenger is obliged to stand on a step for a long period of time, which is often rather uncomfortable. In view of this, a high-speed escalator has been developed. However, in such a high-speed escalator, there is a limitation regarding the traveling speed from the viewpoint of allowing the passengers to get off and on safely. One such high-speed escalator is seen in US 5115 899.

[0003] In view of this, there has been proposed an escalator with a high speed inclined section which is driven at low speed in the upper and lower landing sections where the passenger gets on or off, accelerated or decelerated in the upper and lower curved sections, and driven at high speed in the intermediate inclined section, whereby the requisite time for the passenger to ride on the escalator is shortened. An example of such an escalator with a high speed inclined section is disclosed in Japanese Patent Application Laid-open No. Sho 51-116586.

[0004] However, conventional escalators with a high speed inclined section only exhibit a mechanism for realizing a change in the speed of the steps. Thus, if this speed changing mechanism is simply applied to an ordinary escalator, there is the danger, for example, of a gap being generated between a tread and a riser of an upper adjacent step or interference occurring between adjacent steps.

SUMMARY OF THE INVENTION

[0005] The present invention has been made in view of the above-mentioned problems, and an object of the present invention is to obtain an escalator with a high speed inclined section which is capable of preventing interference of a tread with a riser of an adjacent step or generation of a gap between the riser and the tread in upper and lower landing sections and intermediate inclined sections.

[0006] To this end, according to one aspect of the present invention, there is provided an escalator with a high speed inclined section, wherein assuming that an upper-step-side end of a tread is the origin of a coordinate system when a step is seen from a side with the tread being horizontal and on the upper side, a riser passes a point whose horizontal and vertical coordinates can be expressed as follows:

$$(kr \cos \alpha_m, -kr \sin \alpha_m)$$

(where k is a speed change ratio; r is a distance between the step link roller shafts of the steps adjacent to each other in upper and lower landing sections; and α_m is an inclination angle of a intermediate inclined section).

[0007] Accordingly, it is possible to prevent the tread from interfering with the riser of the adjacent step and to prevent generation of a gap between the riser and the tread in the upper and lower landing sections and the intermediate inclined section.

[0008] According to another aspect of the present invention, there is provided an escalator with a high speed inclined section, wherein assuming that, when steps are seen from a side, a point spaced apart horizontally by $-r$ and vertically by $-R_1$ from a border point which is in movement locus of an axis of a step link roller shaft and which is between an upper landing section and an upper curved section is the origin of a coordinate system and that the horizontal and vertical coordinates of one end M and the other end M' of a movement locus of a link connection point in a speed changing region of an upper curved section are:

$$M(x_M, y_M), M'(x_M', y_M')$$

the following equations hold true:

$$x_M = \{r^2 + L_1^2 - (kr - L_1)^2\} / 2r,$$

$$y_M = R_1 - \sqrt{L_1^2 - x_M^2},$$

$$x_M' = r + R_1 \sin \alpha_m + L_1 \cos \alpha_m,$$

and

$$y_M' = R_1 \cos \alpha_m - L_1 \sin \alpha_m$$

(where r is the distance between the step link roller shafts in the upper and lower landing sections; L_1 is the length between the step link roller shaft and the link connection point in a first link; k is a speed change ratio; and R_1 is a radius of curvature of the upper curved section in the movement locus of the axis of the step link roller shaft).

[0009] Accordingly, in the upper and lower landing sections and an intermediate inclined section, it is possible to prevent interference of the tread with a riser of the adjacent step and generation of a gap between the riser and the tread.

[0010] According to a still further aspect of the present invention, there is provided an escalator with a high speed inclined section, wherein assuming that, when steps are seen from a side, a point spaced apart horizontally by r and vertically by R_2 from a border point which is in movement locus of an axis of a step link roller shaft and which is between a lower landing section and a lower curved section is the origin of a coordinate system and that horizontal and vertical coordinates of one end N and the other end N' of a line indicating a movement locus of a link connection point in a speed changing region of the lower curved section are:

$$N(x_N, y_N), \quad N'(x_N', y_N')$$

the following equations hold true:

$$x_N = -r + \{r^2 + L_1^2 - (kr - L_1)^2\} / 2r,$$

$$y_N = -R_2 - \sqrt{L_1^2 - x_N^2},$$

$$x_N' = -r - R_2 \sin \alpha_m - (kr - L_1) \cos \alpha_m,$$

and

$$y_N' = -R_2 \cos \alpha_m + (kr - L_1) \sin \alpha_m$$

(where r is the distance between the step link roller shafts in the upper and lower landing sections; L_1 is the length between the step link roller shaft and the link connection point in a first link; k is a speed change ratio; and R_2 is a radius of curvature of the lower curved section in the movement locus of the axis of the step link roller shaft).

[0011] Accordingly, in the upper and lower landing sections and an intermediate inclined section, it is possible to prevent interference of the tread with a riser of the adjacent step and generation of a gap between the riser and the tread.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] In the accompanying drawings:

Fig. 1 is a schematic side view of an escalator with a high speed inclined section according to an embodiment of this invention;

Fig. 2 is an enlarged side view of the portion around an upper curved section of Fig. 1;

Fig. 3 is an explanatory diagram illustrating the positional relationship between adjacent steps in upper and lower landing sections of Fig. 1;

Fig. 4 is an explanatory diagram illustrating the positional relationship between adjacent steps in the intermediate inclined section of Fig. 1;

Fig. 5 is an explanatory diagram illustrating the riser configuration of a step according to Embodiment 2 of this invention;

Fig. 6 is an explanatory diagram illustrating the movement track of a link connecting point near an upper curved section of an escalator with a high speed inclined section according to Embodiment 3 of this invention;

Fig. 7 is an explanatory diagram illustrating the movement track of a link connecting point near a lower curved section of an escalator with a high speed inclined section according to Embodiment 4 of this invention; and

Fig. 8 is a side view of an upper reversing section of an escalator with a high speed inclined section according to Embodiment 5 of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] Embodiments of this invention will be described with reference to the drawings.

Embodiment 1

[0014] Fig. 1 is a schematic side view of an escalator with a high speed inclined section according to an embodiment of this invention. In the drawing, a main frame 1 is provided with a plurality of steps 2 connected together in an endless fashion. The steps 2 are driven by a drive unit (step driving means) 3 and circulated.

[0015] The main frame 1 is provided with a pair of main tracks 4 forming a loop track for the steps 2, a pair of trailing tracks 5 for controlling the attitude of the steps 2, and a pair of auxiliary tracks 6 for varying the distance between adjacent steps 2.

[0016] The loop track for the steps 2 has a forward path section, a return track section, an upper reversing section, and a lower reversing section. The forward path section of the loop track has an upper landing section (upper horizontal section) A, an upper curved section B, an intermediate inclined section (fixed inclination section) C, a lower curved section D, and a lower landing section (lower horizontal section) E. The intermediate inclined section C is situated between the upper landing section A and the lower landing section E. The upper curved section B is situated between the upper landing section A and the intermediate inclined section C. The lower curved section D is situated between the lower landing section E and the intermediate inclined section C.

[0017] Next, Fig. 2 is an enlarged side view of the portion around the upper curved section B of Fig. 1. Each step 2 has a tread 7 for carrying the passenger, a riser 8 formed by bending the lower step side portion of the tread 7, a step link roller shaft 9 extending in the width direction of the tread 7, a pair of step link rollers 10 rotatable around the step link roller shaft 9, a trailing roller shaft 11 parallel to the step link roller shaft 9, and a pair of trailing rollers 12 rotatable around the trailing rollers 11. The step link rollers 10 roll on the main tracks 4. The trailing rollers 12 roll on the trailing tracks 5.

[0018] The step link roller shafts 9 of adjacent steps 2 are connected to each other by a pair of link mechanisms (folding links) 13. Each link mechanism 13 has first through fifth links 14 through 18.

[0019] One end portion of the first link 14 is rotatably connected to the step link roller shaft 9. The other end portion of the first link 14 is rotatably connected to the middle portion of the third link 16 through a shaft 19. One end portion of the second link 15 is rotatably connected to the step link roller shaft 9 of the adjacent step 2. The other end portion of the second link 15 is rotatably connected to the middle portion of the third link 16 through the shaft 19.

[0020] One end portion of the fourth link 17 is rotatably connected to the middle portion of the first link 14. One end portion of the fifth link 18 is rotatably connected to the middle portion of the second link 15. The other end portions of the fourth and fifth links 17 and 18 are connected to one end portion of the third link 16 through a slide shaft 20.

[0021] In one end portion of the third link 16, there is provided a guide groove 16a for guiding the sliding of the slide shaft 20 in the longitudinal direction of the third link 16. At the other end of the third link 16, there is provided a rotatable auxiliary roller 21. The auxiliary roller 21 is guided by the auxiliary track 6.

[0022] Through the guiding of the auxiliary roller 21 by the auxiliary track 6, the link mechanism 13 undergoes deformation so as to fold and stretch, and the distance between the step link roller shafts 9, that is, the distance between the adjacent steps 2, is varied. In other words, the line of the auxiliary track 6 is designed such that the distance between the adjacent steps 2 varies. The step speed changing means in Embodiment 1 has the auxiliary track 6, the link mechanism 13, and the auxiliary roller 21.

[0023] Next, the operation of this escalator will be described. The speed of the steps 2 is varied by varying the distance between the step link roller shafts 9 of the adjacent steps 2. That is, in the upper landing section A and the lower landing section E where the passenger gets on or off, the distance between the step link roller shafts 9 is minimum, and the steps 2 move at low speed. In the intermediate inclined section C, the distance between the step link roller shafts 9 is maximum, and the steps 2 move at high speed. In the upper curved section B and the lower curved section D constituting the speed changing portions, the distance between the step link roller shafts 9 is varied, and the steps 2 are accelerated or decelerated.

[0024] The first, second, fourth, and fifth links 14, 15, 17, and 18 form a so-called pantograph type quadruple link mechanism, making it possible to increase or decrease the angle made by the first and second links 14 and 15, with the third link 16 serving as the axis of symmetry, whereby it is possible to vary the distance between the step link roller shafts 9 connected to the first and second links 14 and 15.

[0025] In the landing sections A and E of Fig. 1, the distance between the step link roller shafts 9 of the adjacent steps 2 is minimum. When, from this state, the distance between the main track 4 and the auxiliary track 6 is diminished, the link mechanism 13 operates like the framework of an umbrella when it is opened, and the distance between the step link roller shafts 9 of the adjacent steps 2 increases.

[0026] In the intermediate inclined section C of Fig. 1, the distance between the main track 4 and the auxiliary track 6 is minimum, and the distance between the step link roller shafts 9 of the adjacent steps 2 is maximum. Thus, in this region, the speed of the steps 2 is maximum. Further, in this condition, the first and second links 14 and 15 are substantially arranged in a straight line.

[0027] Next, the method of determining the configuration of the riser 8 according to Embodiment 1 will be described. Fig. 3 is an explanatory diagram showing the positional relationship between the adjacent steps 2 in the upper and lower landing sections A and E of Fig. 1, and Fig. 4 is an explanatory diagram showing the positional relationship between the adjacent steps 2 in the intermediate inclined section C of Fig. 1.

[0028] In the drawings, in the upper and lower landing sections A and E, the steps 2 are arranged horizontally with no gaps therebetween, and the distance between the step link roller shafts 9 of the adjacent steps 2 (or the distance between identical corresponding points) is r . Further, suppose the speed changing ratio (the ratio of the moving speed of the steps 2 in the intermediate inclined section C to the moving speed of the steps 2 in the upper and lower landing sections A and E) is k . Further, suppose the inclination angle of the intermediate inclined section is α_m .

[0029] In this case, the distance between the adjacent steps 2 in the intermediate inclined section C is kr . Further, assuming that the upper-step-side end P_1 of the tread 7 of the step 2 situated on the upper step side is the origin of an coordinate system, the coordinates of the upper-step-side end P_2 of the tread 7 of the step 2 situated on the lower step side can be expressed as follows:

$$(kr \cos \alpha_m, -kr \sin \alpha_m) \dots (1)$$

[0030] Further, when the step 2 is seen from the side with the tread 7 being horizontal and on the upper side, the upper end of the riser 8 is situated at the lower-step-side end Q_1 of the tread 7. Thus, the configuration of the riser 8 is determined so as to be a straight line or a curved line passing the lower-step-side end Q_1 of the tread 7 and the upper-step-side end P_2 of the tread 7 of the step 2 adjacent on the lower step side, whereby it is possible to prevent the tread 7 from interfering with the riser 8 of the adjacent step 2 and to prevent generation of a gap between the riser 8 and the tread 7 in the upper and lower landing sections A and E and the intermediate inclined section C.

Embodiment 2

[0031] Next, Fig. 5 is an explanatory diagram showing the riser configuration in the escalator with a high speed inclined section of Embodiment 2 of this invention. The general construction of the escalator is the same as that of Embodiment 1. In Embodiment 2, the riser 8 has a flat configuration. That is, when the step 2 is seen from the side, the riser 8 exhibits a straight line passing the lower-step-side end Q_1 of the tread 7 and the upper-step-side end P_2 of the tread 7 of the step 2 adjacent on the lower step side.

[0032] Assuming that the angle made by the tread 7 and the riser 8 is θ ,

$$\tan \theta = kr \sin \alpha_m / (kr \cos \alpha_m - r) \dots (2)$$

Thus, θ can be expressed as follows:

$$\theta = k \sin \alpha_m / (k \cos \alpha_m - 1) \quad . \quad . \quad . \quad (3)$$

[0033] In this way, when a flat riser 8 is used, the angle θ of the riser 8 with respect to the tread 7 is restricted by the speed changing ratio k and the inclination angle α_m of the intermediate inclined section C, whereby it is possible to prevent the tread 7 from interfering with the riser 8 of the adjacent step 2 and to prevent generation of a gap between the riser 8 and the tread 7 in the upper and lower landing sections A and E and the intermediate inclined section C.

Embodiment 3

[0034] Next, Fig. 6 is an explanatory diagram showing the movement locus of the link connection point around the upper curved section of an escalator with a high speed inclined section according to Embodiment 3 of this invention. The general construction of the escalator is the same as that of Embodiment 1. In the drawing, the axis of the step link roller shaft 9 moves along the movement locus 30. The shaft 19, which is the link connection point (bending point) of the first link 14 and the second link 15, moves along the movement locus 31.

[0035] In the upper landing section A, the adjacent steps 2 are arranged horizontally without any gap therebetween, and the distance between the axes of the step link roller shafts 9 (which is substantially equal to the length of the tread 7) is r . Further, suppose the speed changing ratio (the ratio of the moving speed of the steps 2 in the intermediate inclined section C to the moving speed of the steps 2 in the upper and lower landing sections A and E) is k . Further, suppose the inclination angle of the intermediate inclined section C is α_m . And, further, suppose the radius of curvature of the movement locus 30 in the upper curved section B is R_1 .

[0036] In this case, the distance between the step link roller shafts 9 in the intermediate inclined section C is kr . Further, suppose the length of the portion of the first link 14 from the step link roller shaft 9 to the link connection point (which is substantially equal to the length of the first link 14) is L_1 , and suppose the length of the portion of the second link 15 from the step link roller shaft 9 to the link connection point (which is substantially equal to the length of the second link 15) is L_2 . Further, in the intermediate inclined section C, the step link roller shaft 9 and the link connection point in the first link 14 and the step link roller shaft 9 in the second link 15 are defined to be in a straight line. In this case, the length L_2 can be expressed as follows:

$$L_2 = kr - L_1 \quad . \quad . \quad . \quad (4)$$

[0037] Next, the coordinates of one end M and the other end M' of the movement locus 31 of the link connection point in the speed changing region are obtained. It is to be assumed that the speed change in the upper portion of the escalator (the folding and stretching of the first link 14 and the second link 15) is completed exclusively in the upper curved section B. Further, the origin of the coordinate system is the point spaced apart horizontally (in the x-direction) by $-r$ and vertically (in the y-direction) by $-R_1$ from the border point E which is in the movement locus 30 of the axis of the step link roller shaft 9 and which is between the upper landing section A and the upper curved section B.

[0038] Here, a case is considered in which the steps 2 are accelerated from the upper landing section A toward the intermediate inclined section C. When the axis of the step link roller shaft 9 of the lower-side step 2 of the adjacent steps 2 in the upper landing section A is positioned at the border point F (r, R_1), which is the acceleration start point, the axis of the step link roller shaft 9 of the upper-side step 2 is positioned at the point G (x_G, y_G) = ($0, R_1$). At this time, the link connection point (shaft 19) is positioned at the start point M of the speed change region of the movement locus 31.

[0039] Assuming that the angle made by segment GF and segment GM is β , the following equation is derived from the second law of cosines regarding the triangle FGM:

$$\cos \beta = (r^2 + L_1^2 - L_2^2) / 2rL_1 = \{r^2 + L_1^2 - (kr - L_1)^2\} / 2rL_1 \quad . \quad . \quad . \quad (5)$$

Thus, the horizontal and vertical coordinates (x_M, y_M) of the point M are expressed as follows:

$$x_M = x_G + L_1 \cos \beta = \{r^2 + L_1^2 - (kr - L_1)^2\} / 2r \quad . \quad . \quad . \quad (6)$$

$$y_M = y_G - \sqrt{(L_1^2 - x_M^2)} = R_1 - \sqrt{(L_1^2 - x_M^2)} \quad . \quad . \quad . \quad (7)$$

[0040] When the axis of the step link roller shaft 9 of the upper-side step 2 is positioned at the border point G' that is between the upper curved section B and the intermediate inclined section C, the acceleration of the lower-side step 2 has been completed, and the link connection point is positioned at the end point M' of the movement locus 31. At this time, the coordinates of the point G', (x_G' , y_G'), can be expressed as follows:

$$x_G' = r + R_1 \sin \alpha_m \quad . . . (8)$$

$$y_G' = R_1 \cos \alpha_m \quad . . . (9)$$

[0041] Further, in the intermediate inclined section C, the step link roller shaft 9 and the link connection point in the first link 14 and the step link roller shaft 9 in the second link 15 are in a straight line, so that M' is a point which is in the movement locus 30 of the axis of the step link roller shaft 9 and in the intermediate inclined section C. Thus, the coordinates of the point M', (x_M' , y_M'), can be expressed as follows:

$$x_M' = x_G' + L_1 \cos \alpha_m = r + R_1 \sin \alpha_m + L_1 \cos \alpha_m \quad . . . (10)$$

$$y_M' = y_G' - L_1 \sin \alpha_m = R_1 \cos \alpha_m - L_1 \sin \alpha_m \quad . . . (11)$$

[0042] In this escalator with a high speed inclined section, the movement locus 31 of the link connection point in the speed change region of the upper portion of the escalator is a straight line or a curved line connecting the end points M and M'. That is, the positions of the end points of the link connection point are determined such that the speed change of the steps 2 in the upper portion of the escalator is effected exclusively in the upper curved section B (the region where the steps 2 undergo a change in difference in level). Thus, in the upper and lower landing sections A and E and the intermediate inclined section C, it is possible to prevent interference of the tread 7 with the riser 8 of the adjacent step 2 and generation of a gap between the riser 8 and the tread 7.

Embodiment 4

[0043] Next, Fig. 7 is an explanatory diagram showing the movement locus of the link connection point near the lower curved section of an escalator with a high speed inclined section according to Embodiment 4 of this invention. The general construction of the escalator is the same as that of Embodiment 1. In the drawing, the speed change in the lower portion of the escalator is completed exclusively in the lower curved section D. Suppose the radius of curvature of the movement locus 30 of the axis of the step link roller shaft 9 in the lower curved section D is R_2 . Further, the origin of the coordinate system is the point spaced apart horizontally (in the x-direction) by r and vertically (in the y-direction) by R_2 from the border point I which is in the movement locus 30 and which is between the lower landing section E and the lower curved section D.

[0044] As in Embodiment 3, one end N(x_N , y_N) and the other end N'(x_N' , y_N') of the movement locus 31 of the link connection point in the speed changing region of the lower portion of the escalator are obtained as follows:

$$x_N = -r + \{r^2 + L_1^2 - (kr - L_1)^2\} / 2r \quad . . . (12)$$

$$y_N = -R_2 - \sqrt{L_1^2 - x_N^2} \quad . . . (13)$$

$$x_N' = -r - R_2 \sin \alpha_m - (kr - L_1) \cos \alpha_m \quad . . . (14)$$

$$y_N' = -R_2 \cos \alpha_m + (kr - L_1) \sin \alpha_m \quad . . . (15)$$

[0045] In this escalator with a high speed inclined section, the movement locus 31 of the link connection point in the

speed changing region of the lower portion of the escalator is a straight line or a curved line having the points N and N' as its ends. That is, the positions of the end points of the link connection point are determined such that the speed change of the steps 2 in the lower portion of the escalator is effected exclusively in the lower curved section D (the region where the steps 2 undergo a change in difference in level). Thus, in the upper and lower landing sections A and E and the intermediate inclined section C, it is possible to prevent interference of the tread 7 with the riser 8 of the adjacent step 2 and generation of a gap between the riser 8 and the tread 7.

[0046] While in Embodiments 3 and 4 the positions of the end points of the movement locus of the link connection point in the speed changing region (upper and lower curved sections) are obtained, it is also possible to geometrically obtain, from the positions of the points obtained, the positions of the end points of the movement locus of the axis of the auxiliary roller and the positions of the end points of the auxiliary track in the speed changing region.

Embodiment 5

[0047] Further, while in the above examples a pantograph type quadruple link mechanism is used, the construction of the link mechanism is not restricted to this; it is also possible, for example, to use a link mechanism 41 as shown in Fig. 8.

[0048] The link mechanism 41 has a first link 42 with a bent middle portion and a second link 43 of a linear configuration. One end portion of the first link 42 is connected to the step link roller shaft 9. An auxiliary roller 21 is mounted to the other end portion of the first link 42. One end portion of the second link 43 is connected to the step link roller shaft 9 of the adjacent step 2. The other end portion of the second link 43 is connected to the link connection point in the middle portion of the first link 42 through a shaft 44. The step speed changing means of Embodiment 5 has the auxiliary track 6, the link mechanism 41, and the auxiliary roller 21.

[0049] Even in the case in which this link mechanism 41 is used, it is possible, as in Embodiments 3 and 4, to obtain the end points of the locus of the link connection point in the speed changing region, whereby it is possible to prevent interference of the tread 7 with the riser 8 of the adjacent step 2 and generation of a gap between the riser 8 and the tread 7 in the upper and lower landing sections and the intermediate inclined section.

Claims

1. An escalator with a high speed inclined section, comprising:

- a plurality of steps (2) each of which has a tread (7) for carrying a passenger, a riser (8) provided at a lower-step-side end of the tread (7), a step link roller shaft (9), and a step link roller (10) rotatable around the step link roller shaft (9) and which are connected together in an endless fashion for circulation;
- a main track (4) which forms a loop track including an upper landing section (A), a lower landing section (E), and an intermediate inclined section (C) situated between the upper landing section (A) and the lower landing section (E) and which guides the step link roller (10); and
- a step speed changing means which varies the distance between adjacent steps (2) to thereby vary the moving speed of the steps (2) such that the ratio of the moving speed in the intermediate inclined section (C) to the moving speed in the upper and lower landing section (A, E) is a predetermined value of a speed change ratio,

characterized in that

assuming that the upper-step-side end of the tread (7) is the origin of a coordinate system when the step is seen from a side with the tread (7) being horizontal and on the upper side, the riser (8) passes a point whose horizontal and vertical coordinates can be expressed as follows:

$$(kr\cos\alpha_m, -kr\sin\alpha_m),$$

where k is the speed change ratio; r is the distance between the step link roller shafts (9) of the steps (2) adjacent to each other in the upper and lower landing section (A, E); and α_m is the inclination angle of the intermediate inclined section (C).

2. The escalator with a high speed inclined section according to Claim 1, wherein the riser (8) is of a flat configuration and wherein the angle θ made by the tread (7) and the riser (8) can be expressed as follows:

$$\theta = k \sin \alpha_m / (k \cos \alpha_m - 1).$$

3. An escalator with a high speed inclined section, comprising:

- a plurality of steps (2) each of which has a tread (7) for carrying a passenger, a riser (8) provided at a lower-step-side end of the tread (7), a step link roller shaft (9), and a step link roller (10) rotatable around the step link roller shaft (9) and which are connected together in an endless fashion for circulation;

- a main track (4) which forms a loop track including an upper landing section (A), a lower landing section (E), an intermediate inclined section (C) situated between the upper landing section (A) and the lower landing section (E), an upper curved section situated between the upper landing section (A) and the intermediate inclined section (C), and a lower curved section situated between the lower landing section (E) and the intermediate inclined section (C) and which guides the main track (4); and

- step speed changing means which have a plurality of link mechanisms (13) each of which has a first link (14) rotatably connected to the step link roller shaft (9) and a second link (15) rotatably connected to a link connection point of the first link (14) and the step link roller shaft (9) of an adjacent step and which vary a distance between the adjacent steps (2) to thereby vary a moving speed of the steps (2) such that a ratio of the moving speed in the intermediate inclined section (C) to the moving speed in the upper and lower landing section (A, E) is a predetermined value of a speed change ratio,

characterized in that

assuming that, when the steps (2) are seen from a side, a point spaced apart horizontally by -r and vertically by -R₁ from a border point which is in movement locus of an axis of the step link roller shaft (9) and which is between the upper landing section (A) and the upper curved section is the origin of a coordinate system and that the horizontal and vertical coordinates of one end M and the other end M' of the movement locus of the link connection point in a speed changing region of the upper curved section are:

$$M (X_M, Y_M), \quad M' (X_M', Y_M')$$

the following equations hold true:

$$X_M = \{r^2 + L_1^2 - (kr - L_1)^2\} / 2r,$$

$$Y_M = R_1 - \sqrt{L_1^2 - X_M^2},$$

$$X_M' = r + R_1 \sin \alpha_m + L_1 \cos \alpha_m,$$

and

$$Y_M' = R_1 \cos \alpha_m - L_1 \sin \alpha_m$$

wherein

r is the distance between the step link roller shafts (9) in the upper and lower landing section (A, E);

L_1 is the length between the step link roller shaft (9) and the link connection point in the first link (14);
 k is the speed change ratio; and
 R_1 is a radius of curvature of the upper curved section in the movement locus of the axis of the step link roller shaft (9).

4. An escalator with a high speed inclined section, comprising:

- a plurality of steps (2) each of which has a tread (7) for carrying a passenger, a riser (8) provided at a lower-step-side end of the tread (7), a step link roller shaft (9), and a step link roller (10) rotatable around the step link roller shaft (9) and which are connected together in an endless fashion for circulation;
- a main track (4) which forms a loop track including an upper landing section (A), a lower landing section (E), an intermediate inclined section (C) situated between the upper landing section (A) and the lower landing section (E), an upper curved section situated between the upper landing section (A) and the intermediate inclined section (C), and a lower curved section situated between the lower landing section (E) and the intermediate inclined section (C) and which guides the main track (4); and
- step speed changing means which have a plurality of link mechanisms (13) each of which has a first link (14) rotatably connected to the step link roller shaft (9) and a second link (15) rotatably connected to a link connection point of the first link (14) and the step link roller shaft (9) of an adjacent step and which vary a distance between the adjacent steps (2) to thereby vary a moving speed of the steps (2) such that a ratio of the moving speed in the intermediate inclined section (C) to the moving speed in the upper and lower landing section (A, E) is a predetermined value of a speed change ratio,

characterized in that

assuming that, when the steps (2) are seen from a side, a point spaced apart horizontally by r and vertically by R_2 from a border point which is in movement locus of an axis of the step link roller shaft (9) and which is between the lower landing section (E) and the lower curved section is the origin of a coordinate system and that horizontal and vertical coordinates of one end N and the other end N' of a line indicating the movement locus of the link connection point in a speed changing region of the lower curved section are:

$$N (X_N, Y_N), \quad N' (X_{N'}, Y_{N'})$$

the following equations hold true:

$$X_N = -r + \{r^2 + L_1^2 - (kr - L_1)^2\}/2r,$$

$$Y_N = -R_2 - \sqrt{(L_1^2 - X_N^2)},$$

$$X_{N'} = -r - R_2 \sin \alpha_m - (kr - L_1) \cos \alpha_m,$$

and

$$Y_{N'} = -R_2 \cos \alpha_m + (kr - L_1) \sin \alpha_m$$

wherein

r is the distance between the step link roller shafts (9) in the upper and lower landing section (A, E);

L_1 is the length between the step link roller shaft (9) and the link connection point in the first link (14);
 k is the speed change ratio; and
 R_2 is a radius of curvature of the lower curved section in the movement locus of the axis of the step link roller shaft (9).

Patentansprüche

1. Rolltreppe mit einem geneigten Hochgeschwindigkeitsbereich, welche Folgendes aufweist:

- eine Vielzahl von Stufen (2), von denen jede eine Trittfläche (7) zum Transportieren eines Benutzers, eine Setzstufe (8), die an einem Ende der Trittfläche (7) in Richtung der niedrigeren Stufe vorgesehen ist, eine Stufenverbindungs-Rollenachse (9) und eine Stufenverbindungsrolle (10) aufweist, die um die Stufenverbindungs-Rollenachse (9) drehbar ist, und die miteinander in einer endlosen Schleife zum Umlaufen verbunden sind;
- eine Hauptbahn (4), die eine schleifenförmige Bahn bildet, die Folgendes aufweist: einen oberen Landebereich (A), einen unteren Landebereich (E) und einen dazwischenliegenden geneigten Bereich (C), der zwischen dem oberen Landebereich (A) und dem unteren Landebereich (E) angeordnet ist, und die die Stufenverbindungsrollen (10) führt; und
- eine Stufengeschwindigkeits-Änderungseinheit, die den Abstand zwischen benachbarten Stufen (2) variiert, um dadurch die Bewegungsgeschwindigkeit der Stufen (2) zu variieren, so dass das Verhältnis der Bewegungsgeschwindigkeit in dem dazwischenliegenden geneigten Bereich (C) zu der Bewegungsgeschwindigkeit in dem oberen und unteren Landebereich (A, E) einen vorbestimmten Wert eines Geschwindigkeits-Änderungsverhältnisses entspricht,

dadurch gekennzeichnet, dass

unter der Annahme, dass ein Ende der Trittfläche (7) in Richtung der höher gelegenen Stufe der Ursprung eines Koordinatensystems ist, wenn die Stufe von einer Seite aus betrachtet wird, wobei die Trittfläche (7) horizontal und auf der oberen Seite ist, die Setzstufe (8) einen Punkt durchläuft, dessen horizontale und vertikale Koordinaten auf folgende Weise ausgedrückt werden können:

$$(kr\cos\alpha_m, -kr\sin\alpha_m),$$

wobei

k das Geschwindigkeits-Änderungsverhältnis ist;

r der Abstand zwischen den Stufenverbindungs-Rollenachsen (9) der Stufen (2) ist, die benachbart zueinander in dem oberen und dem unteren Landebereich (A, E) angeordnet sind; und

α_m der Neigungswinkel des dazwischenliegenden geneigten Bereichs (C) ist.

2. Rolltreppe mit einem geneigten Hochgeschwindigkeitsbereich nach Anspruch 1, wobei die Setzstufe (8) eine flache Anordnung aufweist und wobei der Winkel θ , der durch die Trittfläche (7) und die Setzstufe (8) definiert ist, auf folgende Weise ausgedrückt werden kann:

$$\theta = k\sin\alpha_m / (k\cos\alpha_m - 1).$$

3. Rolltreppe mit einem geneigten Hochgeschwindigkeitsbereich, welche Folgendes aufweist:

- eine Vielzahl von Stufen (2), von denen jede eine Trittfläche (7) zum Transportieren eines Benutzers, eine Setzstufe (8), die an einem Ende der Trittfläche (7) in Richtung der niedrigeren Stufe vorgesehen ist, eine Stufenverbindungs-Rollenachse (9) und eine Stufenverbindungsrolle (10) aufweist, die um die Stufenverbindungs-Rollenachse (9) drehbar ist, und die miteinander in einer endlosen Schleife zum Umlaufen verbunden sind;
- eine Hauptbahn (4), die eine schleifenförmige Bahn bildet, die Folgendes aufweist: einen oberen Landebereich

(A), einen unteren Landebereich (E), einen dazwischenliegenden geneigten Bereich (C), der zwischen dem oberen Landebereich (A) und dem unteren Landebereich (E) angeordnet ist, einen oberen gekrümmten Bereich, der zwischen dem oberen Landebereich (A) und dem dazwischenliegenden geneigten Bereich (C) angeordnet ist, und einen unteren gekrümmten Bereich, der zwischen dem unteren Landebereich (E) und dem dazwischenliegenden geneigten Bereich (C) angeordnet ist, und die die Hauptbahn (4) führt; und
 - eine Stufengeschwindigkeits-Änderungseinrichtung, die eine Vielzahl von Verbindungsmechanismen (13) aufweist, von denen jeder ein erstes Verbindungsglied (14), das mit der Stufenverbindungs-Rollenachse (9) drehbar verbunden ist, und ein zweites Verbindungsglied (15) aufweist, das mit einem Verbindungsglied-Verbindungspunkt des ersten Verbindungsglieds (14) und der Stufenverbindungs-Rollenachse (9) einer benachbarten Stufe drehbar verbunden ist; wobei die Verbindungsmechanismen den Abstand zwischen benachbarten Stufen (2) variieren, um dadurch eine Bewegungsgeschwindigkeit der Stufen (2) zu verändern, so dass das Verhältnis der Bewegungsgeschwindigkeit in dem dazwischenliegenden geneigten Bereich (C) zu der Bewegungsgeschwindigkeit in dem oberen und dem unteren Landebereich (A, E) einem vorbestimmten Wert eines Geschwindigkeits-Änderungsverhältnisses entspricht,

dadurch gekennzeichnet, dass

unter der Annahme, dass dann, wenn die Stufen (2) von einer Seite aus betrachtet werden, ein Punkt, der von einem Grenzpunkt horizontal um $-r$ und vertikal um $-R_1$ versetzt ist, der Ursprung eines Koordinatensystems ist; wobei der Grenzpunkt sich auf einer Bewegungs-Ortskurve einer Achse der Stufenverbindungs-Rollenachse (9) befindet und zwischen dem oberen Landebereich (A) und dem oberen gekrümmten Bereich angeordnet ist; und unter der Annahme, dass die horizontalen und vertikalen Koordinaten des einen Endes M und des anderen Endes M' der Bewegungs-Ortskurve des Verbindungsglied-Verbindungspunkts in einem Bereich der Geschwindigkeitsänderung des oberen gekrümmten Bereichs Folgende sind:

$$M (X_M, Y_M), \quad M' (X_M', Y_M')$$

die folgenden Gleichungen erfüllt sind:

$$X_M = \{r^2 + L_1^2 - (kr - L_1)^2\}/2r,$$

$$Y_M = R_1 - \sqrt{L_1^2 - X_M^2},$$

$$X_M' = r + R_1 \sin \alpha_m + L_1 \cos \alpha_m,$$

and

$$Y_M' = R_1 \cos \alpha_m - L_1 \sin \alpha_m$$

wobei

r der Abstand zwischen den Stufenverbindungs-Rollenachsen (9) in dem oberen und dem unteren Landebereich (A, E) ist;

L_1 die Länge zwischen der Stufenverbindungs-Rollenachse (9) und dem Verbindungsglied-Verbindungspunkt in dem ersten Verbindungsglied (14) ist; k das Geschwindigkeits-Änderungsverhältnis ist; und

R_1 der Krümmungsradius des oberen gekrümmten Bereichs in der Bewegungs-Ortskurve der Achse der Stufenverbindungsrollensachse (9) ist.

4. Rolltreppe mit einem geneigten Hochgeschwindigkeitsbereich,
welche Folgendes aufweist:

- eine Vielzahl von Stufen (2), von denen jede eine Trittfläche (7) zum Transportieren eines Benutzers, eine Setzstufe (8), die an einem Ende der Trittfläche (7) in Richtung der niedrigeren Stufe vorgesehen ist, eine Stufenverbindungs-Rollenachse (9) und eine Stufenverbindungsrolle (10) aufweist, die um die Stufenverbindungs-Rollenachse (9) drehbar ist, und die miteinander in einer endlosen Schleife zum Umlaufen verbunden sind;
- eine Hauptbahn (4), die eine schleifenförmige Bahn bildet, die Folgendes aufweist: einen oberen Landebereich (A), einen unteren Landebereich (E), einen dazwischenliegenden geneigten Bereich (C), der zwischen dem oberen Landebereich (A) und dem unteren Landebereich (E) angeordnet ist, einen oberen gekrümmten Bereich, der zwischen dem oberen Landebereich (A) und dem dazwischenliegenden geneigten Bereich (C) angeordnet ist, und einen unteren gekrümmten Bereich, der zwischen dem unteren Landebereich (E) und dem dazwischenliegenden geneigten Bereich (C) angeordnet ist, und die die Hauptbahn (4) führt; und
- eine Stufengeschwindigkeits-Änderungseinrichtung, die eine Vielzahl von Verbindungsmechanismen (13) aufweist, von denen jeder ein erstes Verbindungsglied (14), das mit der Stufenverbindungs-Rollenachse (9) drehbar verbunden ist, und ein zweites Verbindungsglied (15) aufweist, das mit einem Verbindungsglied-Verbindungspunkt des ersten Verbindungsglieds (14) und der Stufenverbindungs-Rollenachse (9) einer benachbarten Stufe drehbar verbunden ist; wobei die Verbindungsmechanismen den Abstand zwischen benachbarten Stufen (2) variieren, um dadurch eine Bewegungsgeschwindigkeit der Stufen (2) zu verändern, so dass das Verhältnis der Bewegungsgeschwindigkeit in dem dazwischenliegenden geneigten Bereich (C) zu der Bewegungsgeschwindigkeit in dem oberen und dem unteren Landebereich (A, E) einem vorbestimmten Wert eines Geschwindigkeits-Änderungsverhältnisses entspricht,

dadurch gekennzeichnet, dass

unter der Annahme, dass dann, wenn die Stufen (2) von einer Seite aus betrachtet werden, ein Punkt, der von einem Grenzpunkt horizontal um r und vertikal um R_2 versetzt ist, der Ursprung eines Koordinatensystems ist; wobei sich der Grenzpunkt auf einer Geschwindigkeits-Ortskurve einer Achse der Stufenverbindungs-Rollenachse (9) befindet und zwischen dem unteren Landebereich (E) und dem unteren gekrümmten Bereich angeordnet ist; und unter der Annahme, dass die horizontalen und vertikalen Koordinaten des einen Endes N und des anderen Endes N' auf einer Linie, die die Geschwindigkeits-Ortskurve des Verbindungsglied-Verbindungspunkts in einem Geschwindigkeits-Änderungsbereich des unteren gekrümmten Bereichs anzeigt, Folgende sind:

$$N (X_N, Y_N), \quad N' (X_{N'}, Y_{N'})$$

die folgenden Gleichungen erfüllt sind:

$$X_N = -r + \{r^2 + L_1^2 - (kr - L_1)^2\}/2r,$$

$$Y_N = -R_2 - \sqrt{L_1^2 - X_N^2},$$

$$X_{N'} = -r - R_2 \sin \alpha_m - (kr - L_1) \cos \alpha_m,$$

and

$$Y_{N'} = -R_2 \cos \alpha_m + (kr - L_1) \sin \alpha_m$$

wobei

r der Abstand zwischen den Stufenverbindungs-Rollenachsen (9) in dem oberen und dem unteren Landebereich (A, E) ist;

L_1 die Länge zwischen der Stufenverbindungs-Rollenachse (9) und dem Verbindungsglied-Verbindungspunkt in dem ersten Verbindungsglied (14) ist; k das Geschwindigkeits-Änderungsverhältnis ist; und

R_2 der Krümmungsradius des unteren gekrümmten Bereichs auf der Bewegungs-Ortskurve der Achse der Stufenverbindungs-Rollenachse (9) ist.

Revendications

1. Escalier roulant avec une section inclinée à haute vitesse, comprenant:

- une pluralité de marches (2), chacune d'elles ayant un giron (7) pour porter un passager, une contremarche (8) prévue sur une extrémité du giron (7) du côté de la marche inférieure, un axe à roulement de liaison de marches (9), et un roulement de liaison de marches (10) capable de rotation autour de l'axe à roulement de liaison de marches (9), et qui sont connectées ensemble dans une boucle sans fin pour la circulation;
- une voie principale (4) qui forme une voie en boucle incluant une section de palier supérieure (A), une section de palier inférieure (E), et une section inclinée intermédiaire (C) située entre la section de palier supérieure (A) et la section de palier inférieure (E) et qui guide le roulement de liaison de marches (10); et
- un moyen de changement de vitesse des marches qui fait varier la distance entre des marches adjacentes (2) pour faire varier ainsi la vitesse de déplacement des marches (2) de telle façon que le rapport de la vitesse de déplacement dans la section inclinée intermédiaire (C) sur la vitesse de déplacement dans la section de palier supérieure et la section de palier inférieure (A, E) est une valeur prédéterminée d'un rapport de changement de vitesses,

caractérisé en ce que,

en supposant que l'extrémité du giron (7) du côté de la marche supérieure est l'origine un système de coordonnées lorsqu'on regarde la marche depuis le côté avec le giron (7) horizontal et sur le côté supérieur, la contremarche (8) passe à un point dont les coordonnées horizontale et verticale peuvent être exprimées comme suit:

$$(kr \cos \alpha_m - kr \sin \alpha_m),$$

dans laquelle k est le rapport de changement de vitesses; r est la distance entre les arbres à roulement de liaison de marches (9) des marches (2) mutuellement adjacentes dans la section de palier supérieure et la section de palier inférieure (A, E); et α_m est l'angle d'inclinaison de la section inclinée intermédiaire (C).

2. Escalier roulant avec une section inclinée à haute vitesse selon la revendication 1, dans lequel la contremarche (8) a une configuration plane, et dans lequel l'angle θ , fait par le giron (7) et la contremarche (8), peut être exprimé comme suit:

$$\theta = k \sin \alpha_m / (k \cos \alpha_m - 1).$$

3. Escalier roulant avec une section inclinée à haute vitesse, comprenant:

- une pluralité de marches (2), chacune d'elles ayant un giron (7) pour porter un passager, une contremarche (8) prévue à une extrémité du giron (7) du côté de la marche inférieure, un arbre à roulement de liaison de marches (9), et un roulement de liaison de marches (10) capable de rotation autour de l'arbre à roulement de liaison de marches (9) et qui sont connectées ensemble dans une boucle sans fin pour la circulation;
- une voie principale (4) qui forme une voie en boucle incluant une section de palier supérieure (A), une section de palier inférieure (E), une section inclinée intermédiaire (C) située entre la section de palier supérieure (A) et la section de palier inférieure (E), une section incurvée supérieure située entre la section de palier supérieure (A) et la section inclinée intermédiaire (C), et une section incurvée inférieure située entre la section de palier inférieure (E) et la section inclinée intermédiaire (C) et qui guide la voie principale (4); et

- un moyen de changement de vitesse des marches qui comprend une pluralité de mécanismes à bras (13), dont chacun a un premier bras (14) connecté en rotation à l'arbre à roulement de liaison de marches (9) et un second bras (15) connecté en rotation à un point de connexion de bras du premier bras (14) et à l'arbre à roulement de liaison de marches (9) d'une marche adjacente, et qui fait varier une distance entre les marches adjacentes (2) pour faire ainsi varier une vitesse de déplacement des marches (2) de telle façon qu'un rapport de la vitesse de déplacement dans la section inclinée intermédiaire (C) sur la vitesse de déplacement dans la section de palier supérieure et dans la section de palier inférieure (A, E) est une valeur prédéterminée d'un rapport de changement de vitesses,

caractérisé en ce que

en supposant que, quand les marches (2) sont vues depuis un côté, un point écarté horizontalement de $-r$ et verticalement de $-R_1$ depuis un point de bordure qui est un lieu de mouvement d'un axe de l'arbre à roulement de liaison de marches (9) qui se trouve entre la section de palier supérieure (A) et la section incurvée inférieure est l'origine un système de coordonnées, et que les coordonnées horizontale et verticale d'une extrémité M et de l'autre extrémité M' du lieu de mouvement du point de connexion de liaison dans une région de changement de vitesses de la section incurvée supérieure sont:

$$M (X_M, Y_M), \quad M' (X_{M'}, Y_{M'}),$$

les équations suivantes s'appliquent:

$$X_M = \{r^2 + L_1^2 - (kr - L_1)^2\}/2r,$$

$$Y_M = R_1 - \text{SQRT}(L_1^2 - X_M^2),$$

$$X_{M'} = r + R_1 \sin \alpha_m + L_1 \cos \alpha_m,$$

et

$$Y_{M'} = R_1 \cos \alpha_m - L_1 \sin \alpha_m$$

dans lesquelles

r est la distance entre les arbres à roulement de liaison de marches (9) dans la section de palier supérieure et dans la section de palier inférieure (A, E);

L_1 est la longueur entre l'arbre à roulement de liaison de marches (9) et le point de connexion de liaison dans le premier bras (14);

k est le rapport de changement de vitesses; et

R_1 est un rayon de courbure de la section incurvée supérieure dans le lieu de mouvement de l'axe de l'arbre à roulement de liaison de marches (9).

4. Escalier roulant avec une section inclinée à haute vitesse, comprenant:

- une pluralité de marches (2), chacune d'elle ayant un giron (7) pour porter un passager, une contremarche (8) prévue sur une extrémité du giron (7) du côté de la marche inférieure, un arbre à roulement de liaison de marches (9) et un roulement de liaison de marches (10) capable de rotation autour de l'arbre à roulement de liaison de marches (9), et qui sont connectées ensemble dans une boucle sans fin pour la circulation;

- une voie principale (4) qui forme une voie en boucle incluant une section de palier supérieure (A), une section de palier inférieure (E), une section inclinée intermédiaire (C) située entre la section de palier supérieure (A) et la section de palier inférieure (E), une section incurvée supérieure située entre la section de palier supérieure (A) et la section inclinée intermédiaire (C), et une section incurvée inférieure située entre la section de palier inférieure (E) et la section inclinée intermédiaire (C), et qui guide la voie principale (4); et

des moyens de changement de vitesses des marches, qui ont une pluralité de mécanismes à bras (13), dont chacun à un premier bras (18) connecté en rotation à l'arbre à roulement de liaison de bras (9), et un second bras (15) connecté en rotation à un point de connexion de bras du premier bras (14), et l'arbre à roulement de liaison de marches (9) d'une marche adjacente, et qui fait varier une distance entre des marches adjacentes (2) pour faire ainsi varier une vitesse de déplacement des marches (2), de telle façon qu'un rapport de la vitesse de déplacement dans la section inclinée intermédiaire (C) sur la vitesse de déplacement dans la section de palier supérieure et la section de palier inférieure (A, E) est une valeur prédéterminée d'un rapport de changement de vitesses,

caractérisé en ce que

en supposant que, quand les marches (2) sont vues depuis un côté, un point espacé horizontalement de r et verticalement de R_2 depuis un point de bordure qui est un lieu de mouvement d'un axe de l'arbre à roulement de liaison de marches (9) et qui est entre la section de palier inférieure (E) et la section incurvée inférieure est l'origine d'un système de coordonnées, et que les coordonnées horizontale et verticale d'une extrémité N et de l'autre extrémité N' d'une ligne indiquant le lieu de mouvement du point de connexion de bras dans une région de changement de vitesses de la section incurvée inférieure sont:

$$N (X_N, Y_N), \quad N' (X_{N'}, Y_{N'}),$$

les équations suivantes s'appliquent:

$$X_N = -r + \{r^2 + L_1^2 - (kr - L_1)^2\}/2r,$$

$$Y_N = -R_2 - \text{SQRT}(L_1^2 - X_N^2),$$

$$X_{N'} = -r - R_2 \sin \alpha_m - (kr - L_1) \cos \alpha_m,$$

et

$$Y_{N'} = -R_2 \cos \alpha_m + (kr - L_1) \sin \alpha_m$$

dans lesquelles

r est la distance entre les arbres à roulement de liaison de marches (9) dans la section de palier supérieure et la section de palier inférieure (A, E);

L_1 est la longueur entre l'arbre à roulement de liaison de marches (9) est le point de connexion de bras dans le premier bras (14);

k est le rapport de changement de vitesses; et

R_2 est un rayon de courbure de la section incurvée inférieure du lieu de mouvement de l'axe de l'arbre à roulement de liaison de marches (9).

FIG. 1

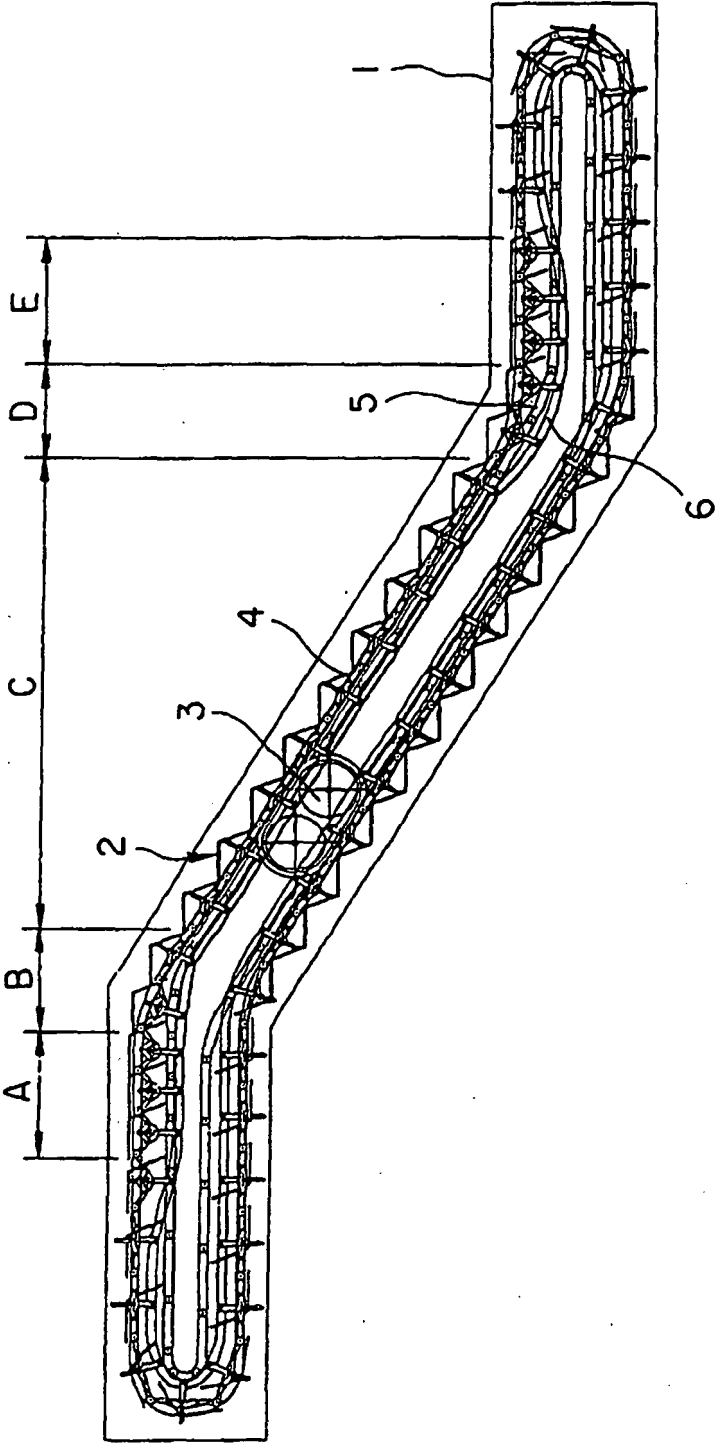


FIG. 2

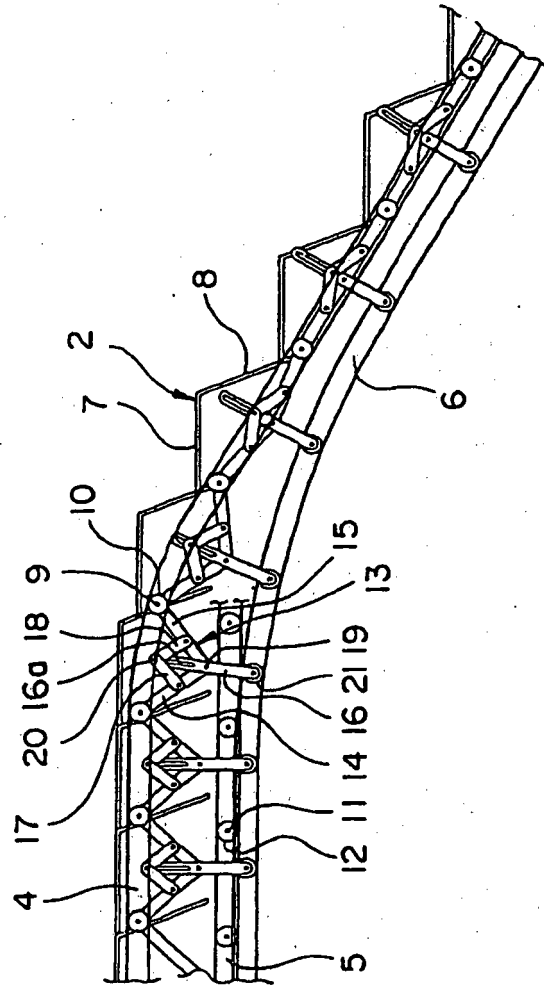


FIG. 3

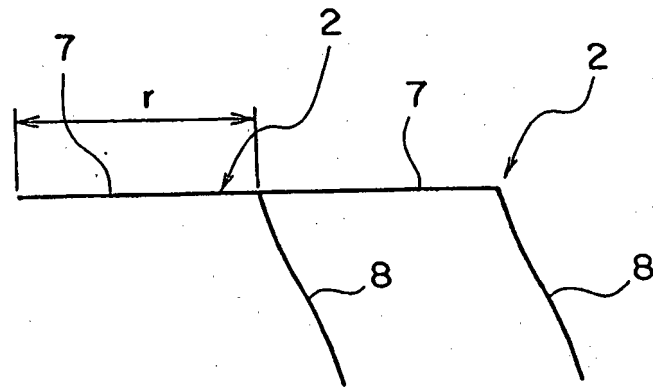


FIG. 4

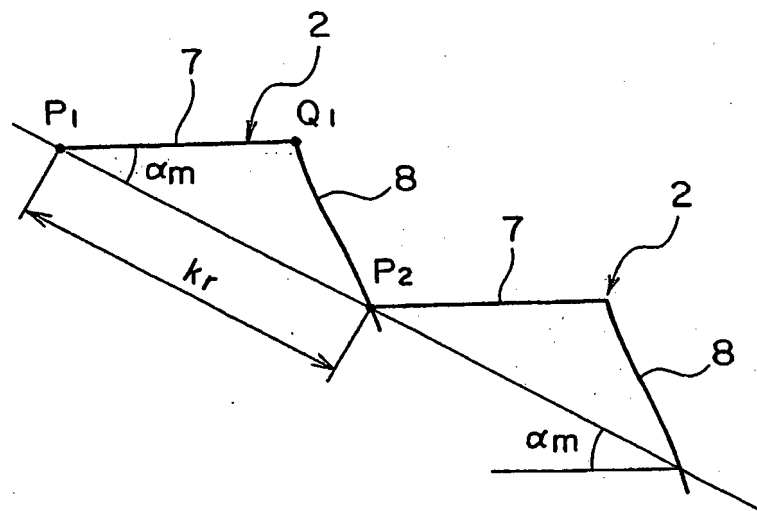


FIG. 5

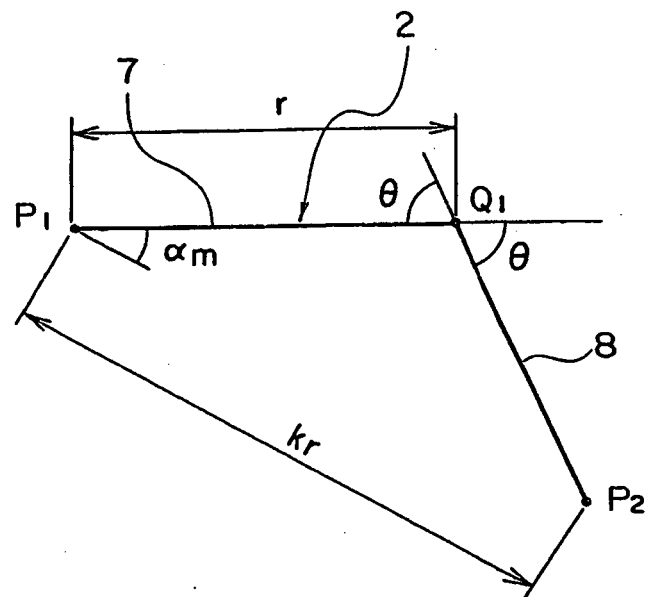


FIG. 6

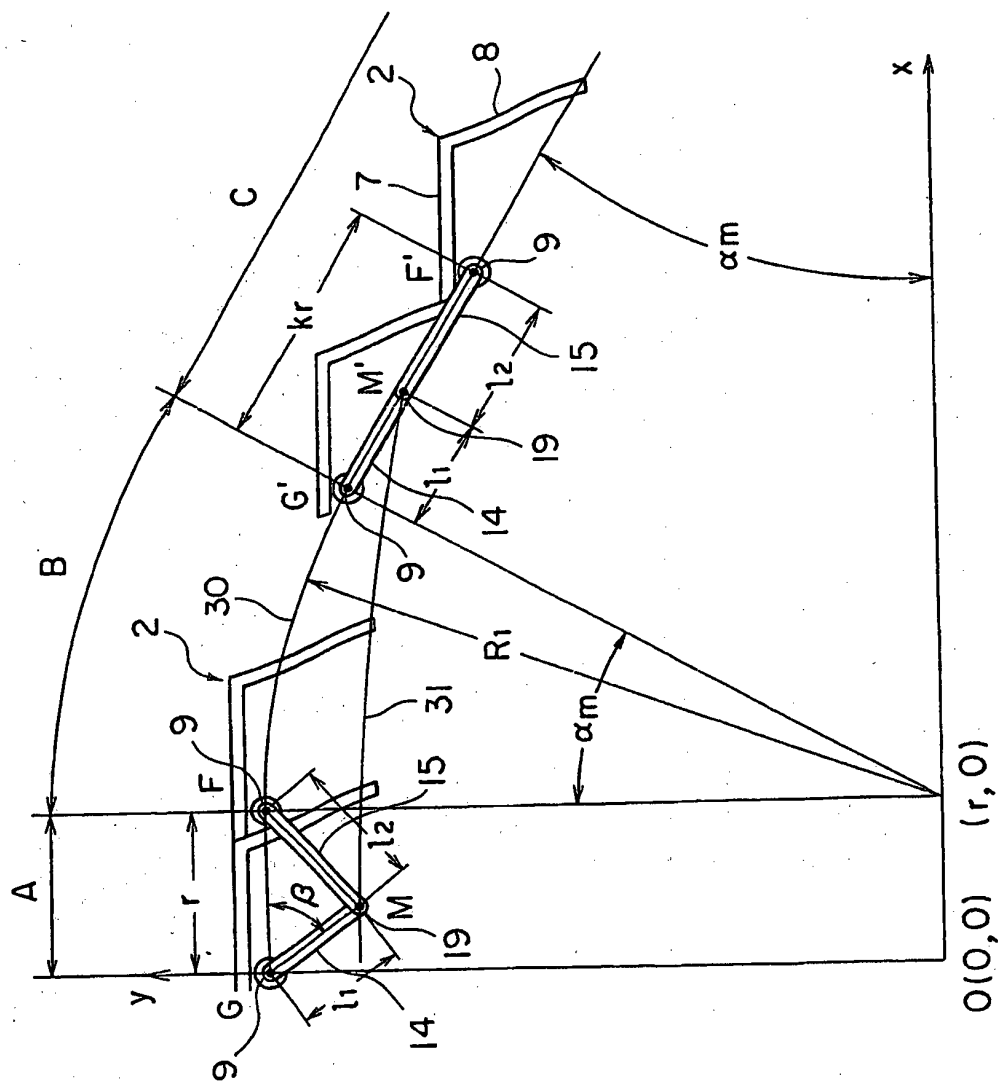


FIG. 7

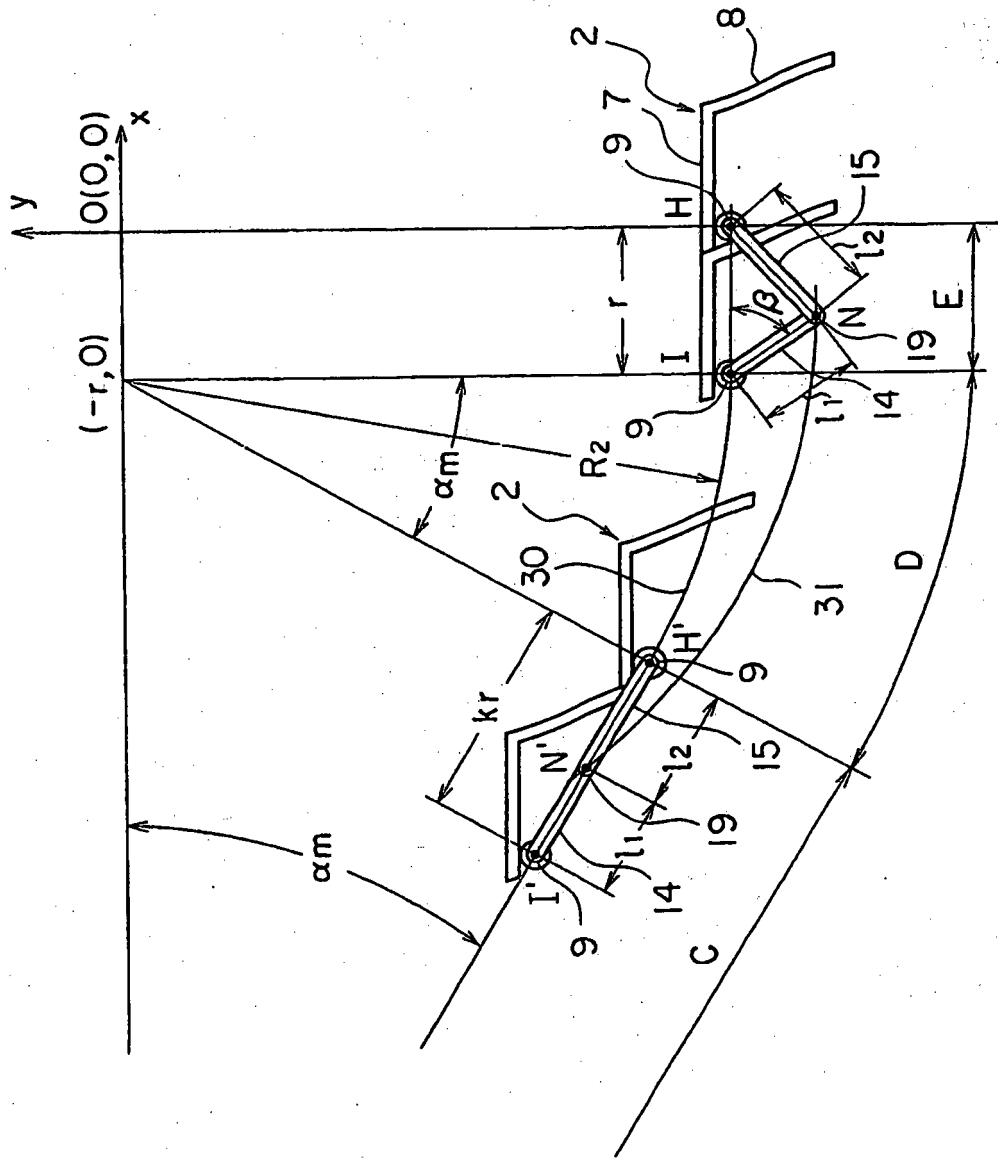
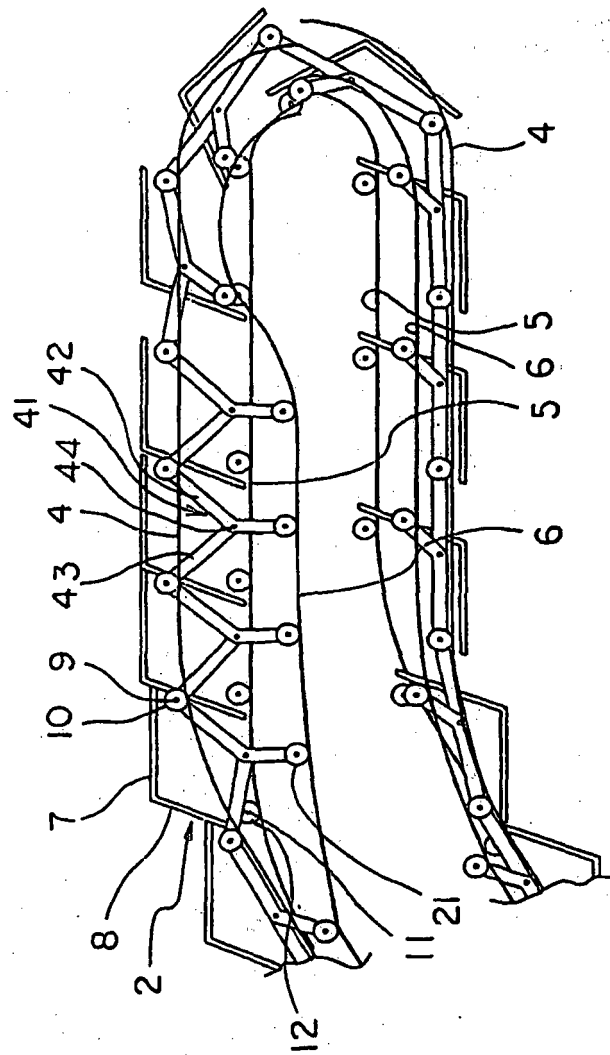


FIG. 8



REFERENCES CITED IN THE DESCRIPTION

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